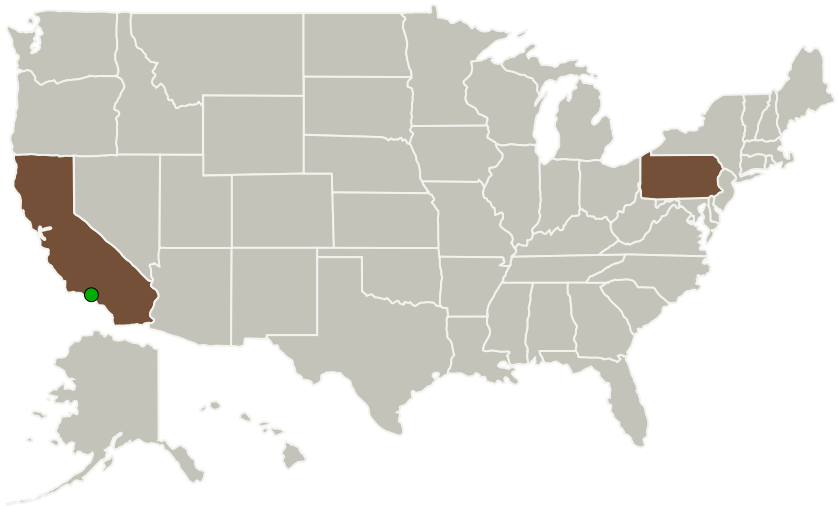
Intelligent Spectrometry for Robotic Explorers, Phase I

Completed Technology Project (2014 - 2014)

Project Introduction

Our aim in this project is to apply the state-of-the-art in science autonomy, including the PI's recent work at Carnegie Mellon in areas of automatic spectrometer targeting and spectra collection, science-guided path planning, and orbital terrain classification, to the creation of Intelligent Spectrometry for Robotic Explorers (ISRE). In our vision, ISRE will enable real-time, on-board analysis of spectroscopic data to guide spectrometer targeting. Spectrometer targeting involves both selecting rover navigational goals and directing a spectrometer foreoptic to accurately measure intended target rocks or soil. The expected result is that the most informative science targets will be automatically sampled and that quality of the science data return will improve while the required scientist effort and necessary communication bandwidth will be reduced. ISRE will employ algorithms to segment images into spectrally-similar regions using feature extraction and classification. These regions can be targeted for spectrometry and experiment-design techniques will be applied to determine the best sampling strategy for coverage and signal maximization without resource wasting oversampling. The rover-collected spectra can then be unmixed into endmembers that can be associated with orbital observations or geologically interpreted by scientists. Classified spectra can be aggregated into maps, used to detect spectral distinctions including outliers, and interpreted to plan spacecraft actions more likely to produce informative results. Our specific innovations are: feature extraction for image segmentation and spectral clustering; discovering exceptional (outlier) spectra, which may have significant scientific value; associating spectral endmembers with geologic terrain; rover path planning for science sample collection; and integration of algorithms into an open-source framework.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Mesh Robotics, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

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Organizations Performing Work	Role	Type	Location
Mesh Robotics, LLC	Lead Organization	Industry	Pittsburgh, Pennsylvania
Carnegie Mellon University	Supporting Organization	Academia	Pittsburgh, Pennsylvania
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Pennsylvania

Project Transitions

June 2014: Project Start

December 2014: Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/137648)*

Images

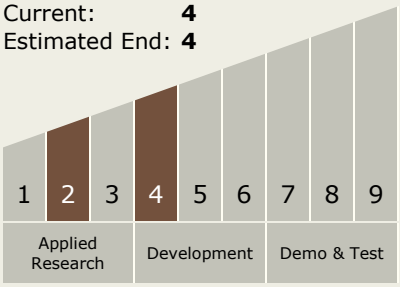
Project Image
Intelligent Spectrometry for Robotic Explorers Project Image
(https://techport.nasa.gov/image/129731)

Project Management *(cont.)*

Principal Investigator:
David Wettergreen

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors
    - TX08.3.4 Environment Sensors

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System